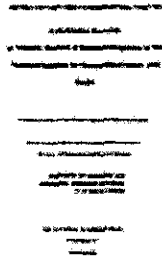


Free Executive Summary

Construction Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health

Committee to Review the NIOSH Construction
Research Program, National Research Council

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Summary

ABSTRACT *The construction industry is one of the largest sectors of the U.S. economy, accounting for about 13 percent of the gross domestic product and employing about 11 million workers in 2005. Construction is also one of the most dangerous industries for workers. Hazards for construction workers include working at heights, in excavations and tunnels, on highways, and in confined spaces; exposure to high levels of noise, to chemicals, and to high-voltage electric lines; and the use of power tools and heavy equipment. Significant health risks include hearing loss, silicosis, musculoskeletal disorders, skin diseases, and health effects associated with exposures to lead, asphalt fumes, and welding fumes.*

The National Institute for Occupational Safety and Health (NIOSH) has conducted construction-relevant research activities since the 1970s. In 1990, Congress directed NIOSH to develop a comprehensive prevention program directed at health problems affecting construction workers by expanding existing NIOSH activities in areas of surveillance, research, and intervention. During the study period 1996 through 2005, the NIOSH Construction Research Program focused on four research goals: reducing the major risks associated with traumatic injuries and fatalities; reducing exposure to health hazards; reducing major risks associated with musculoskeletal disorders; and increasing the understanding of construction industry attributes and factors for improving health and safety outcomes.

In conjunction with planned reviews of up to 15 NIOSH research programs, the Division on Engineering and Physical Sciences of the National Research Council convened a committee of experts to evaluate the relevance and impact of the NIOSH Construction Research Program. The committee evaluated the relevance of the program in terms of its research priorities and its connection to improvements in the protection of workers in the workplace; it evaluated the impact of the program in terms of its contributions to worker safety and health. The committee was also asked to assess the program's identification and targeting of new research areas, to identify emerging research issues, and to provide advice on ways that the program might be strengthened.

NIOSH cannot, on its own, set and enforce research-based standards or practices for the construction industry. These efforts are carried out respectively by the Occupational Safety and Health Administration (OSHA) and by individual contractors, unions, and other entities. Nonetheless the Construction Research Program can be expected to contribute to reductions in construction workplace fatalities, injuries, and illnesses through its research, its research dissemination, and transfer to practice. Taking into account a range of external factors beyond the control of the NIOSH Construction Research Program, the committee found

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that the program has indeed made meaningful contributions to improving construction worker safety and health.

The review by this committee was conducted on the basis of a framework established by a parent committee appointed by the National Research Council. Using a 5-point scoring scale (with 5 being the highest), the committee assigned the Construction Research Program a score of 5 for relevance, indicating that the research is in high-priority areas and that NIOSH is significantly engaged in appropriate transfer activities for completed research projects and reported program results. Regarding impact, the committee assigned the program a score of 4, indicating that the research program has made some contributions to end outcomes (worker safety and health) or well-accepted intermediate outcomes.

To ensure the continued high level of relevance for the program's research and to enhance the impact of that research on health and safety practices within the construction industry, the committee recommends that research-to-practice (R2P) efforts involve individuals trained in or having the experience and skills to create strategic diffusion and social marketing plans for NIOSH research and to evaluate such plans' effectiveness; that consideration be given to having the majority of R2P efforts conducted through the National Construction Center; that high-level attention by NIOSH leadership be given to determining how to provide program resources that are commensurate with a more robust pursuit of the program's goals; that the positions of Construction Program Coordinator and Construction Program Manager both become full-time positions; that the National Construction Center continue to be used as an important component in NIOSH's Construction Research Program; and that the program establish a closer connection with OSHA and other regulatory and consensus standards organizations that can ensure that the program's research is applied effectively in rule-making efforts.

Between 1992 and 2005, 16,000 construction workers in the United States died from work-related injuries. In 2005 alone, 1,243 construction workers died from job-related traumatic injuries. This number accounted for 22 percent of job-related deaths across all industries, a figure that is disproportionately high given that construction workers account for about 8 percent of the total workforce. The death rate for construction workers was almost three times that of full-time workers for all industries: 11.1 deaths per 100,000 construction workers compared with 4.2 deaths per 100,000 workers in all industries (CPWR, 2007, Section 32). Among all sectors, construction had the fourth highest rate of fatalities in 2005 (after agriculture, mining, and transportation) and the second highest rate of nonfatal injuries and illnesses (after transportation) as measured by days away from work: 239.5 per 10,000 construction workers compared with 135.7 per 10,000 workers for all industries (CPWR, 2007, Section 32).

Nonetheless, the trends in construction workplace safety show significant improvements. Between 1992 and 2005, the overall rate of construction-related fatalities declined from 14.3 to 11.1 per 100,000 workers, which translates to 350 fewer deaths per year for a workforce of 11 million. The rate of nonfatal injuries

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and illnesses also declined significantly, although the absolute rate of decline is not clear owing to changes in reporting requirements.¹ An additional complicating factor is that a large portion of the construction sector is not reflected in nonfatal injuries and illnesses statistics, because many workers are self-employed or work in construction firms that employ fewer than 10 workers, categories for which such statistics are not collected.

The National Institute for Occupational Safety and Health (NIOSH) was established by the Occupational Safety and Health Act of 1970 (Public Law 91-596) to “conduct . . . research, experiments, and demonstrations, relating to occupational safety and health and to develop innovative methods, techniques, and approaches for dealing with [those] problems.” The law also created the Occupational Safety and Health Administration (OSHA) to set and enforce standards for workplace safety and health and to work with employers and employees through technical assistance and consultation programs.

NIOSH, unlike OSHA, is not authorized to set and enforce standards. Instead, NIOSH as a research organization is authorized to carry out the following:

- Develop recommendations for occupational safety and health standards
- Conduct research on worker safety and health
- Conduct training and employee education
- Develop information on safe levels of exposure to toxic materials and harmful physical agents and substances
- Conduct research on new safety and health problems
- Conduct on-site investigations (health hazard evaluations) to determine the toxicity of materials used in workplaces, and
- Fund research by other agencies or private organizations through grants, contracts, and other arrangements (CFR, 2008)

NIOSH has conducted research on health and safety hazards in the construction industry since the 1970s. The NIOSH Construction Research Program was formally established in 1990 after Congress directed NIOSH to develop a comprehensive prevention program focused on health and safety problems affecting construction workers by expanding existing NIOSH activities in the areas of surveillance, research, and intervention.

¹In 2002, the Occupational Safety and Health Administration implemented a number of changes in the definitions of injury and illness cases recorded by employers. The new definitions in turn resulted in changes in occupational injury and illness statistics provided by the Bureau of Labor Statistics. There is some disagreement as to the overall effect of these changes. For example, one author writes that “while these data follow the trend of declining cases and rates seen throughout the past decade, because of the change in definition they cannot be compared with data from prior years” (Wiatrowski, 2004). In contrast, others note that although the changes in coding systems have significantly affected the compatibility of injury and illness data for construction subsectors over time, the impact on the construction industry as a whole is relatively small (CPWR, 2007, Section 32).

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STUDY BACKGROUND AND STATEMENT OF TASK

In September 2004, NIOSH requested that the National Academies conduct evaluation reviews of up to 15 specific NIOSH research programs to assess the relevance and impact of the work of NIOSH in reducing workplace injury and illness. For consistency across the set of evaluations, each review is using a methodology and framework developed by the National Academies' Committee for the Review of NIOSH Research Programs (called the Framework Committee). The conduct of these reviews has been guided by the Framework Document presented in Appendix A.

In 2007, the National Research Council appointed the Committee to Review the NIOSH Construction Research Program, composed of experts from a wide range of disciplines who have worked in industry, academia, government, and labor unions (Appendix D provides biosketches of the committee members). The committee was tasked with reviewing NIOSH's Construction Research Program and evaluating the program's relevance and impact. The committee evaluated the relevance of the program in terms of its research priorities and its connection to improvement in the protection of workers in the workplace; it evaluated the impact of the program in terms of its contributions to worker safety and health. The committee was also asked to assess the program's identification and targeting of new research areas, to identify emerging research issues, and to provide advice on ways that the program might be improved. The committee chose the time period 1996 through 2005 for its review.

NIOSH CONSTRUCTION RESEARCH PROGRAM

The mission of the NIOSH Construction Research Program is to eliminate occupational diseases, injuries, and fatalities among individuals working in the construction industry through a focused program of research and prevention (NIOSH, 2007).

Between 1996 and 2005, the program focused on four general research goals:

- Goal 1: Reduce the major risks associated with traumatic injuries and fatalities in construction.
- Goal 2: Reduce exposures to health hazards associated with major risks of occupational illness in construction.
- Goal 3: Reduce the major risks associated with musculoskeletal disorders in construction.
- Goal 4: Increase understanding of construction sector attributes that affect occupational safety and health outcomes.

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Two to six sub-goals are associated with each of the four major goals. The goals are a composite of goals and priorities that draw from the first National Occupational Research Agenda (NORA1) and internally generated strategic goals and high-priority topics.

To achieve its goals, the program uses a three-pronged structure to conduct research and disseminate research results: NIOSH-wide intramural research and surveillance programs, a National Construction Center cooperative agreement, and support grants and agreements for investigator-initiated extramural research projects (Figure S.1):

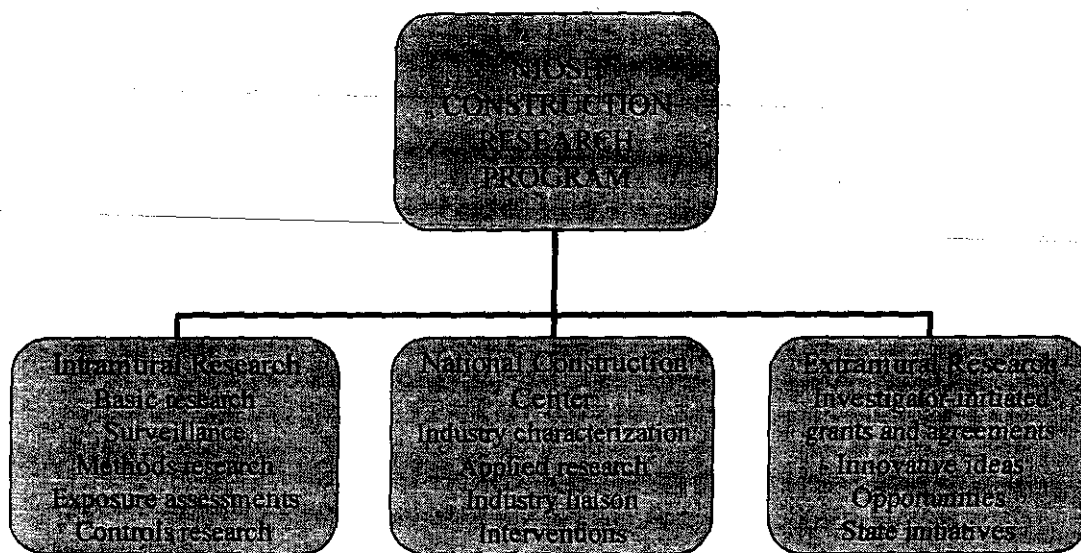


FIGURE S.1 Components of the NIOSH Construction Research Program.

- *Intramural research* is carried out by in-house researchers assigned to six divisions and associated laboratories throughout NIOSH, rather than by a distinct construction research organizational entity. As such, the program operates as a matrix organization within NIOSH. Activities that focus on basic research, surveillance, methods research, exposure assessments, and controls are managed through a coordinator and a Construction Steering Committee (CSC). Composed of representatives from each NIOSH division and laboratory², the CSC briefs NIOSH senior executives on issues relating to the Construction Research Program.

² The divisions are Applied Research and Technology; Surveillance, Hazard Evaluations and Field Studies; Education and Information; Respiratory Disease Studies; Safety Research; Health Effects; Pittsburgh Research Laboratory; Spokane Research Laboratory, the Office of Extramural Projects; and National Personal Protective Technology. NIOSH's laboratories are located in Pittsburgh, Pennsylvania; Spokane, Washington; Cincinnati, Ohio; and Morgantown, West Virginia.

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- *The National Construction Center (NCC)* is operated under a competitively awarded (scientifically and programmatically reviewed) 5-year cooperative agreement.³ The NCC focuses on industry characterization, applied research, creating liaisons with the industry, and developing research-based interventions. The research is conducted by NCC staff dedicated to construction research, and through a consortium of universities whose staff conduct research through contracts with the NCC.
- *Extramural research* is conducted through investigator-initiated extramural grants and cooperative agreements (all scientifically and programmatically reviewed); and through support for state health department investigators working on construction health and safety surveillance and state-level initiatives.

Research conducted in any one component of the program is leveraged by way of interactions with researchers in the other two components during regularly scheduled meetings, construction conferences, and other construction-specific networking opportunities.

Total annual funding for the program between fiscal year (FY) 1997 and FY 2007 (which would overlap the study period) has averaged about \$17.8 million, ranging from a high of \$20.3 million in FY 1997 to a low of \$13.8 million in FY 2007. When adjusted for inflation and changes in technologies, the funding level for the program has declined in terms of real purchasing power (NIOSH, 2007). Program funding levels have also declined as a portion of the total budget for NIOSH.

STUDY PROCESS

The reviews of all NIOSH research programs are being conducted using a methodology and framework described in the Framework Document (Appendix A). Inputs to the review of the Construction Research Program included information provided by the NIOSH program staff in oral presentations, a 500-page evidence package, and written responses to committee questions. The committee also received input from program stakeholders, including representatives from labor, industry, regulatory agencies, professional organizations, and academia (Appendix B). Individual committee members conducted research independently and also shared their collective expertise.

³ The NCC is currently awarded to the Center to Protect Workers' Rights (CPWR). In 2008 the CPWR changed its name to "CPWR: The Center for Construction Research and Training."

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EXTERNAL FACTORS

As outlined in the Framework Document, the committee identified *external factors*—defined as actions or forces beyond the Construction Research Program's control with important bearing on the ability of the program to effect change (that is, to have an impact on intermediate and end outcomes) in the workplace.

A fundamental external factor is the fact that the Construction Research Program and NIOSH are research entities lacking rule-making authority. As such, the program can produce knowledge about safety and health hazards in the construction workplace and provide for the transfer of this knowledge through a range of activities. However, the responsibility for issuing and enforcing workplace standards lies with rule-making authorities such as OSHA, while the responsibility for adopting evidence-based best practices lies with construction project owners and contractors. Thus, although the Construction Research Program can make recommendations to these groups and individuals, how their recommendations are used, if at all, is beyond its control.

A second external factor is the segmentation of the industry, which has four distinctly different sectors—residential, commercial, industrial, and heavy construction. This segmentation affects the transfer of research findings and promising interventions into practice. For example, it is easier to translate research into practice in the heavy construction and industrial sectors, where project owners are more involved and cognizant of health and safety issues, and through labor unions, which have structures for training and information dissemination. Economic factors that some construction owners and contractors may believe to be unfavorable to the implementation of health and safety programs may also play a role.

Other significant factors that have influenced the extent of the program's impact include (1) inadequate funding for conducting the full range of research required and for developing the products, tools, training, and other methods to translate that research into practice; (2) the lack (until recently) of a full-time senior-level person to coordinate the array of projects and activities carried out by the program and (3) the lack (until 2006) of a Construction Program Manager to advocate for construction research and resources and to hold the program accountable for meeting its objectives.

EVALUATION PROCESS

To ensure an in-depth review of the available information, the committee formed four teams, each one reviewing the part of the Construction Research Program's evidence package corresponding to one of the four research goals and related sub-goals. The teams assessed the various activities of the program and reviewed the body of work resulting from these activities. The committee also assessed the intermediate and end outcomes resulting from these activities.

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Using the scoring criteria from the Framework Document (included here as Box S.1), each committee member provided an independent rating for relevance and impact for the goal area reviewed by his or her team. The full committee then held substantive discussions to eventually arrive at a consensus on final ratings for relevance and impact for the total program. The committee also considered external factors that have affected and continue to affect the program.

BOX S.1 Framework Document Scoring Criteria for Relevance and Impact	
Scoring Criteria for Relevance	Scoring Criteria for Impact
5 = Research is in high-priority subject areas and NIOSH is significantly engaged in appropriate transfer activities for completed research projects/reported research results.	5 = Research program has made major contribution(s) to worker health and safety on the basis of end outcomes or well-accepted intermediate outcomes.
4 = Research is in priority subject areas and NIOSH is engaged in appropriate transfer activities for completed research projects/reported research results.	4 = Research program has made some contributions to end outcomes or well-accepted intermediate outcomes.
3 = Research is in high priority or priority subject areas, but NIOSH is not engaged in appropriate transfer activities; or research focuses on lesser priorities but NIOSH is engaged in appropriate transfer activities.	3 = Research program activities are ongoing and outputs are produced that are likely to result in improvements in worker health and safety (with explanation of why not rated higher). Well accepted outcomes have not been recorded.
2 = Research program is focused on lesser priorities and NIOSH is not engaged in or planning some appropriate transfer activities.	2 = Research program activities are ongoing and outputs are produced that may result in new knowledge or technology, but only limited application is expected. Well accepted outcomes have not been recorded.
1 = Research program is not focused on priorities and NIOSH is not engaged in transfer activities.	1 = Research activities and outputs do not result in or are NOT likely to have any application.
	NA = Impact cannot be assessed; program not mature enough
SOURCE: Reprinted from Boxes 2 and 3 of "Framework for the Review of Research Programs of the National Institute for Occupational Safety and Health", reproduced as Appendix A in this report.	

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Evaluation of Relevance: Score of 5

The scoring criteria for relevance are tied to the priority of the research areas focused on and to the level of activity for transferring research to practice. The committee found that the program's priorities for safety-related goals were closely aligned with national and state surveillance data identifying the leading causes of fatalities and injuries. Similarly, its focus on Hispanic workers, the largest "subpopulation" within construction, was appropriate and of high priority.

The program's process for prioritizing research on health hazards was not as transparent. In part, this can be attributed to the lack of national and state surveillance data regarding the extent of health hazards caused by specific agents and in comparison with the health hazards caused by other agents. However, it was clear that the research areas chosen for health-related hazards did affect large numbers of workers across the entire construction industry.

The committee also discussed each of the four program goals and their associated research activities at length. The discussion involved a very deliberate process of examining the language for the scoring criteria. Immediate consensus emerged that at a minimum a rating of 4 would apply—that is, research is in priority areas and the program is engaged in appropriate transfer activities. The discussion then turned to a closer examination of the criteria for a score of 5 to determine if the research conducted for each goal was in high-priority subject areas and whether the program was "significantly engaged in appropriate transfer activities for completed research projects/reported research results." (The scoring guidance does not allow for the assignment of scores using decimals, for example 4.5.)

The committee determined that the Construction Research Program was clearly engaged in high-priority activities given its focus on the leading causes of fatalities (Goal 1), health hazards that affect large numbers of construction workers (Goals 2 and 3), and significant subpopulations (Sub-goal 4.2).

The committee also determined that the Construction Research Program was significantly engaged in appropriate transfer activities. Across the program, research-to-practice activities have involved a wide range of industry stakeholders, technologies, training methods, and information-dissemination activities. The program has contributed to the development of OSHA standards and worked directly with state agencies and industry stakeholders to transfer information and protective measures to the worker in the field. Stakeholder groups indicated to the committee that program-generated publications brought value to the industry by offering a means for informing their management, staffs, and members about newly developed or improved industry practices.

On the basis of its determination that the research conducted was high priority in nature and that the program was significantly engaged in appropriate transfer activities, the committee assigned the Construction Research Program a score of 5 for relevance.

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The committee did not view this score as a statement that the program could not be improved, however. The high score instead reflects the guidance for ranking established in the Framework Document and the committee's recognition of the financial constraints within which the program has operated. For these reasons, the committee's evaluation is retrospective. During the course of its discussions and evaluation, the committee identified areas on which the program should focus in the future. Those recommendations are prospective and are meant to help ensure that the program continues to work in high-priority areas.

Evaluation of Impact: Score of 4

The committee evaluated the impact of the Construction Research Program using the same process that it used for relevance. The scoring criteria for impact are linked to a program's contributions to worker health and safety based on end outcomes or well-accepted intermediate outcomes. In terms of end outcomes, the committee concluded that the program, through its development of some technologies such as fall-protection equipment and proximity warning systems, has made some contributions to the overall declines in fatalities and injuries, although the full extent of that impact is not known. Additionally, the program has had a positive impact on the health of workers exposed to asphalt fumes generated during road-paving operations.

The program has also been responsible for a large range of intermediate outcomes. Its research on musculoskeletal disorders is cited in about half of all publications on this topic. The program has provided evidence for the development of OSHA standards on ergonomics, hearing conservation, respiratory crystalline silica, trenching practices, and lead in construction. Some of these standards have been issued, others have not. However, whether the standards are issued and enforced is beyond the control of the program. Its training and training dissemination activities have been extensive, and it is likely that they have contributed to the prevention and reduction of health and safety hazards on some construction worksites.

The committee also determined that the segmentation of the industry and the less-than-adequate level of resources have had a bearing on the program's impact. Thus, although program-generated publications, technologies, and training are relevant for all segments of the construction industry, their diffusion has varied by construction sector. It is particularly difficult to reach the residential sector because so many residential contractors are self-employed or employ fewer than 10 workers. The level of funding available limits the ability of the program to conduct surveillance research and to provide more direct training to owners and workers in this sector.

Using the scoring criteria for rating the program's impact, the committee determined that the Construction Research Program has made some contributions to construction health and safety as measured by either end outcomes or well-accepted intermediate outcomes. However, committee members had divergent views as to whether these contributions could be classified as major contributions

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across the entire program. On that basis, the committee assigned the program an impact score of 4. As it did with respect to the program's relevance, the committee made recommendations intended to improve the program's impact in the future.

FUTURE RESEARCH AREAS

The committee was asked to assess the Construction Research Program's effectiveness in targeting new research areas and identifying emerging issues most relevant to future improvements in the protection of workers in the workplace. The committee's analysis of emerging issues and its recommendations for future research are based on discussions with stakeholders, on the NIOSH evidence package, and on individual committee members' knowledge of the construction industry and their backgrounds and expertise. In addition, the committee reviewed a number of priority topics identified by the Construction Steering Committee in 2002 as areas where research would be most likely to improve the program's impact. The Construction Steering Committee's topics were grouped into three categories:

1. Health and injury outcome topics that target the following:
 - Leading types of fatal and nonfatal traumatic injuries in construction;
 - Low-back injuries and other cumulative work-related musculoskeletal disorders among construction workers; and
 - Occupational illness topics that focus on respiratory disease and hearing loss. Respiratory disease includes airways disease, asthma, chronic obstructive lung disease, and silicosis.
2. Chemical and physical exposure topics that target the following:
 - Vibration,
 - Asphalt fumes, and
 - Lead and dust particles.
3. Approach and sector topics that target the following groups and issues within construction:
 - Small and self-employed contractors;
 - Special subpopulations at risk within construction, such as Hispanic workers, day laborers, young workers, and aging workers;
 - The role of project design as a primary prevention tool for addressing construction hazards;
 - Addressing work organization in construction and improving the understanding of how it affects health and safety;
 - Working with building owners and clients to promote and evaluate construction best practices; and

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- Leveraging promising approaches from related high-risk sectors such as agriculture and mining into construction.

Some of these topics were further developed into NIOSH Construction Research Program strategic goals in 2005. NIOSH shared these strategic goals as input to the NORA Construction Sector Council in 2006, and most but not all of these 2002 and 2005 topics were subsequently incorporated in some form into the NORA2 Preliminary Draft National Construction Agenda Strategic Goals (BOX S.2).

BOX S.2 NORA2 Preliminary Draft National Construction Agenda Strategic Goals
STRATEGIC GOAL 1.0—Reduce construction worker fatalities and serious injuries caused by falls to a lower level
STRATEGIC GOAL 2.0—Reduce fatal and nonfatal injuries from contact with electricity among construction workers
STRATEGIC GOAL 3.0—Reduce fatal and serious injuries associated with struck-by incidents associated with objects, vehicles, and collapsing materials and structures
STRATEGIC GOAL 4.0—Reduce hearing loss among construction workers by increased use of noise reduction solutions, practices, and hearing conservation programs by the construction community
STRATEGIC GOAL 5.0—Reduce silica exposures and future silicosis risks among construction workers by increasing the availability and use of silica dust controls and practices for tasks associated with important exposures
STRATEGIC GOAL 6.0—Reduce welding fume exposures and future related health risks among construction workers by increasing the availability and use of welding fume controls and practices for welding tasks
STRATEGIC GOAL 7.0—Reduce the incidence and severity of work-related musculoskeletal disorders among construction workers in the U.S.
STRATEGIC GOAL 8.0—Increase understanding of factors that comprise both positive and negative construction safety and health cultures; and, expand the availability and use of effective interventions to maintain safe

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work practices 100% of the time in the construction industry.

STRATEGIC GOAL 9.0—Improve the effectiveness of safety and health management programs in construction and increase their use in the industry.

STRATEGIC GOAL 10.0—Improve understanding of how construction industry organization factors relate to injury and illness outcomes, and increase the sharing and use of industry-wide practices, policies, and partnerships that improve safety and health performance.

STRATEGIC GOAL 11.0—Increase the recognition and awareness of construction hazards and the means for controlling them through broad dissemination of quality training for construction workers, including non-English speaking workers.

STRATEGIC GOAL 12.0—Increase understanding of how vulnerable worker groups experience disproportionate risks in construction work and expand the availability and use of effective interventions to reduce injuries and illnesses among these groups.

STRATEGIC GOAL 13.0—Increase the use of “prevention through design (PtD)” approaches to prevent or reduce safety and health hazards in construction.

STRATEGIC GOAL 14.0—Improve surveillance at the Federal, State, and private level to support the identification of hazards and associated illnesses and injuries, the evaluation of intervention and organizational program effectiveness, and the identification of emerging health and safety priorities in construction.

SOURCE: NORA Construction Sector Council (2008).

Goals 1.0 through 7.0 of that set are classified as “outcome” goals that will result in actual reductions in injuries, exposures, illnesses, and disorders among construction workers. Goals 8.0 through 14.0 are classified as “contributing factor” goals. These are defined as factors that represent important influences impacting the likelihood that prevention and control measures and actions are taken on a construction site.

Some of these topics represent areas in which the Construction Research Program is already engaged, offering important opportunities to move research into practice. The committee’s recommendations regarding future research areas

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are presented within the context of the NORA2 goals in Chapter 4. The committee is particularly interested in emphasizing to the Construction Research Program staff that they place an increased amount of research time, effort, and resources on the contributing factors goals within NORA2, specifically Strategic Goals 8.0 through 14.0.

For all of the goals, the committee also recommends that the program keep the worker and contractor in mind as the ultimate destination for its R2P efforts. Following are two critical research questions that should remain in the forefront of these efforts: (1) How can the program get vital information to the worker "in the trench" or "on the steel"? and (2) How does the program persuade contractors and workers to effectively use the interventions that are developed through research?

**OVERARCHING RECOMMENDATIONS FOR PROGRAM
IMPROVEMENT**

The overarching recommendations listed below apply to the Construction Research Program as a whole. Recommendations regarding specific research topics are presented in Chapter 4, in the section entitled "New and Emerging Research Areas."

Transferring Research to Practice

Recommendation 1: Research-to-practice (R2P) efforts should involve individuals trained in or having the experience and skills to create strategic diffusion and social marketing plans for National Institute for Occupational Safety and Health research and to evaluate such plans' effectiveness.

Recommendation 2: Consideration should be given to having the majority of research-to-practice efforts of the Construction Research Program conducted through the National Construction Center.

A number of barriers currently exist within the program structure that limit the R2P efforts and likely their effectiveness. First, although the most recent cooperative agreement for the National Construction Center included language to stipulate that 20 percent of direct costs be directed to increase the knowledge base for effective diffusion of research to practice for construction, in most cases this is not enough to implement more active dissemination strategies and evaluate their effectiveness. Outputs generated by external grantees and partners need to be included in the program's R2P efforts as well. Internally, program researchers have been encouraged to translate research findings to lay publications for target audiences and stakeholders. Indeed, an R2P plan is now a requirement for all internally funded projects.

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The individual expertise called for by the committee in Recommendation 1 above does not necessarily need to reside in NIOSH staff. It could also be expertise within other government agencies such as the Centers for Disease Control and Prevention or OSHA or within the private sector, called on by the program to accomplish its diffusion goals more effectively.

Given that NIOSH is a federal agency, the document review process can be lengthy, and limitations are sometimes placed on what can and cannot be said, given that recommendations may be interpreted as policy. The National Construction Center is not constrained by these barriers however, and thus consideration should be given to having the majority of R2P efforts conducted through the NCC; see Recommendation 2 above. This would allow the program staff to partner with NCC researchers and stakeholders and to focus on conducting the diffusion-related research necessary to determine the optimum ways to reach target audiences.

Resources

Recommendation 3: High-level attention should be given to determining how to provide program resources that are commensurate with a more robust pursuit of the Construction Research Program's goals.

Recommendation 4: The Construction Program Coordinator and the Construction Program Manager should both be devoted full-time to the Construction Research Program..

Recommendation 5: The National Construction Center should continue to be used as an important component in the Construction Research Program.

During its review, the committee concluded that, in spite of budget constraints, the Construction Research Program has made an impact on one of the most dangerous and largest of U.S. industries. The total budget for the program from FY1997 through FY2007 has, in fact, stayed even or slightly declined in real dollars. It has also been declining as a portion of the total NIOSH budget during all of the 1996-2005 review period. The committee finds the funding level inadequate and recommends that high-level attention be given to determining how to provide program resources that are commensurate with a more robust pursuit of the program's goals (see Recommendation 3, above).

A related matter, addressed in Recommendation 4 above, is that until very recently, NIOSH senior management had not made the commitment to assign at least one full-time senior-level staff person to coordinate the array of projects and activities carried out within the program. The committee supports NIOSH's action in making this a full-time position and recommends that NIOSH continue this practice into the future.

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Until 2005, program activities were directed through the Construction Steering Committee, which is composed of representatives from NIOSH divisions and laboratories. In 2005, NIOSH appointed a senior lead team representative as the Construction Program Manager. The committee supports this action and recommends that this position also be devoted full-time to the Construction Research Program. The committee encourages NIOSH to ensure that this position has some level of budgetary authority and management responsibility so that the Construction Program Manager can provide strategic and programmatic leadership and also assist in holding the program accountable for achieving its future research goals.

As indicated in Recommendation 5 above, the committee also recommends that the National Construction Center continue to be used as an important component in NIOSH's Construction Research Program.

Increased Communication with Rule-Making Authorities

Recommendation 6: The Construction Research Program should establish a closer connection with the Occupational Safety and Health Administration, and other regulatory or consensus standards organizations which can ensure that the program's research is applied effectively in rule-making efforts.

The committee recommends that the program increase its current level of communication with OSHA, and other regulatory or consensus standards organizations about the evidence generated from its research activities. In addition to discussing research findings, program staff should communicate more fully on the economics of occupational disorders and illnesses and their impact on workers and contractors in the industry. Such information will provide valuable supporting documentation for recommendations made by the program with respect to regulatory action. Any role that the Construction Research Program can play in developing or strengthening standards that address risk exposure will likely increase its impact on risk reduction for occupational disorders and illnesses.

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BOX S.3

Summary of Overarching Recommendations

The recommendations listed below apply to the Construction Research Program as a whole. Discussion of these recommendations appears in Chapter 4 in the section "Overarching Recommendations for Program Improvement." Recommendations regarding specific research topics are presented in Chapter 4, in the section entitled "New and Emerging Research Areas."

The committee recommends that

1. Research-to-practice (R2P) efforts should involve individuals trained in or having the experience and skills to create strategic diffusion and social marketing plans for National Institute for Occupational Safety and Health research and to evaluate such plans' effectiveness.
2. Consideration should be given to having the majority of research-to-practice efforts of the Construction Research Program conducted through the National Construction Center.
3. High-level attention should be given to determining how to provide program resources that are commensurate with a more robust pursuit of the Construction Research Program's goals.
4. The Construction Program Coordinator and the Construction Program Manager should both be devoted full-time to the Construction Research Program.
5. The National Construction Center should continue to be used as an important component in the Construction Research Program.
6. The Construction Research Program should establish a closer connection with the Occupational Safety and Health Administration and other regulatory or consensus standards organizations which can ensure that the program's research is applied effectively in rule-making efforts.

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Construction Research
at NIOSH: Reviews of Research Programs of the
National Institute for Occupational Safety and
Health

Committee to Review the NIOSH Construction Research Program

Board on Infrastructure and the Constructed Environment

Division on Engineering and Physical Sciences

INSTITUTE OF MEDICINE AND
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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

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Preface

Construction is unique among U.S. industries, annually producing buildings and infrastructure valued at more than \$1.2 trillion. Industry practitioners characterize the industry by four distinctly different sectors—residential, commercial, industrial, and heavy construction—with specialty trade contractors (e.g., carpenters, plumbers) involved in all four sectors. The sector differences are significant because they affect the implementation of worker safety and health programs.

The residential sector is the largest of the four sectors, but also the least organized, with millions of small contractors and a relatively unstructured craft environment. The commercial buildings sector is characterized by specialized subcontractors, with more highly trained workers structured around recognized building trades. The industrial sector is about the same size as the commercial buildings sector; it involves generally larger construction firms, operating in a direct-hire mode, with highly skilled workers and coordinated safety and health efforts. The heavy-construction sector, which builds roads, bridges, and other infrastructure, is more equipment-oriented, less labor-intensive, and primarily involves public-sector owners.

Buildings, structures, and infrastructure—the products of construction projects—last 20 to 100 years or more. In contrast, construction projects and the industry itself can be described as “temporary.” Projects are built within several years; they may be located anywhere in the country. Organizations and personnel involved with a construction project change continuously: Individual organizations and personnel may not have worked together previously, and they may come from many different backgrounds and cultures. In the residential and commercial sectors particularly, crafts and trades workers are likely to work at more than one site or project during any given week or other time frame.

The unique nature of construction activities has resulted in the formation of specialized trades. The members of 1 of about 15 normally recognized building trades—for example, masons—have highly specialized but varied skills that have been developed over years of training and apprenticeship. Thus, construction crafts persons are in many ways highly knowledgeable artisans who are respected not only for their manual skills but also for their technical knowledge related to their specific crafts and to other interfacing crafts.

The uniqueness of the construction industry presents a challenge for occupational safety and health protection. The work environment is inherently less safe during construction than it is after construction is completed: For example, stairways and handrails are much safer after completion than during installation. Moreover, the work environment changes daily for individual workers as construction progresses, and the workers themselves change as different crafts are called in while a project is being built. Worker exposure to hazardous environments is difficult to track because workers move from project to project or company to company during their careers.

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For all of these reasons, conducting research intended to improve the health and safety of construction workers is challenging. Empirical data for work-related illnesses and diseases are particularly difficult to gather owing to the temporary nature of the work and the latent nature of health and musculoskeletal disorders. Equally difficult is finding ways to transfer research results into workplace behaviors and practices that reduce fatalities, injuries, and illnesses at the worksite.

Nonetheless, it appears that significant progress has been made in reducing construction-related fatalities and injuries in recent years. The Occupational Safety and Health Administration and the Bureau of Labor Statistics have provided standard definitions for "Total Recordable Incident Rates" and "Days Away from Work Injuries" that, along with reporting requirements, have allowed meaningful tracking of job-site injury rates. These rates have declined, possibly by a factor of two, over the past 15 years. The fatality rate attributed to construction incidents has also significantly declined. Much of this improvement can arguably be attributed to the leading industry companies and worker organizations, along with the support of construction equipment manufacturers, who have made concerted and organized efforts to provide safer workplaces. Increasing health care costs may have helped to spur greater attention to the prevention of injuries. In some industry sectors the culture has changed from contending that "Construction is inherently dangerous—accidents happen" to holding that "Zero accidents are achievable." These improvements can also be attributed in part to the research and activities of the National Institute for Occupational Safety and Health's (NIOSH's) Construction Research Program.

In 2004, the National Institute for Occupational Safety and Health asked the National Academies to review up to 15 specific NIOSH research programs to determine their relevance to and impact on various industries in the United States. The Committee to Review the NIOSH Construction Research Program was composed of persons with widely diverse backgrounds who have worked in academia, government, industry, and labor unions. To complete its tasks, the committee worked diligently, convening a series of meetings and also employing conference calls and e-mail correspondence. The NIOSH staff provided useful and complete information and was available to answer committee questions. The National Research Council (NRC) staff provided invaluable assistance in gathering information and arranging interviews with industry representatives, in accordance with committee requests.

This report is reflective of many months of intense effort by the committee, the NIOSH staff, and the NRC staff. The committee's ratings for the relevance and impact of the Construction Research Program are made in the context of the program's limited resources, the segmentation of the industry, and other factors beyond the control of the program itself.

Chapter 1 of this report describes the background of the study and provides context for the committee's evaluation. Chapter 2 describes the NIOSH Construction Research Program and external factors that influence the capacity of the program to meet its goals and objectives. Chapter 3 describes activities

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undertaken by the Construction Research Program related to the four major research goals that the program focused on during the period of this study (between 1996 and 2005); it provides the committee's detailed assessment, evaluation, and ratings with respect to the program's relevance and impact in reducing workplace fatalities, injuries, and illnesses. Chapter 4 contains the committee's recommendations regarding areas of future research and program improvement.

Despite many obstacles, the committee believes that the NIOSH Construction Research Program has been highly relevant and has made important contributions to the reduction of fatalities, injuries, and illnesses at construction worksites. The committee hopes that this report will provide valuable guidance to NIOSH as it structures its Construction Research Program for the next decade.

Richard L. Tucker,

Chair

Committee to Review
the NIOSH
Construction
Research Program

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Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

John C. Bailar III, University of Chicago,
Amit Bhattacharya, University of Cincinnati,
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David H. Wegman, University of Massachusetts, Lowell, and
Wm. A. Wulf, University of Virginia.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Richard Wright former director of the Building and Fire Research Laboratory of the National Institute of Standards and Technology. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

The committee also acknowledges and appreciates the contribution of the members of the Board on Infrastructure and the Constructed Environment (BICE) of the National Research Council. The board members were not asked to endorse the committee's conclusions or recommendations or to review the final draft of the report before its release.

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Abbreviations and Acronyms

ABLES	Adult Blood Lead Epidemiology and Surveillance
ACCSH	Advisory Committee on Construction Safety and Health
AFL-CIO	
ANSI	American National Standards Institute
BLS	Bureau of Labor Statistics
BRDPI	Biomedical Research and Development Price Index
CDC	Centers for Disease Control and Prevention
COSH	Council for Occupational Safety and Health
CPWR	Center to Protect Workers' Rights
CSC	Construction Steering Committee
DARTs	days away from work, days of restricted work activity or job transfer
EC	Evaluation Committee
eLCOSH	electronic Library of Construction Occupational Safety and Health
EPA	Environmental Protection Agency
FACE	Fatality Assessment and Control Evaluation
FTE	full-time equivalent
FY	fiscal year
GDP	gross domestic product
HUD	Department of Housing and Urban Development
ITCP	Internal Traffic Control Plan
IUOE	International Union of Operating Engineers
MSD	musculoskeletal disorders
MSHA	Mine Safety and Health Administration
NAICS	North American Industry Classification System

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NCC	National Construction Center
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NOES	National Occupational Exposure Survey
NOHS	National Occupational Hazard Survey
NORA	National Occupational Research Agenda
NORA1	National Occupational Research Agenda 1996-2005
NORA2	National Occupational Research Agenda 2005-forward
NRC	National Research Council
NTOF	National Traumatic Occupational Fatalities
NTP	National Toxicology Program
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OHPL	overhead power lines
OSHA	Occupational Safety and Health Administration
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PATH	Posture, Activity, Tools and Handling
PWS	Proximity Warning System
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R2P	Research to Practice
RFAs	Requests for Applications
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SENSOR	Sentinel Event Notification Systems for Occupational Risk
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TRIR	Total Recordable Incident Rate